same in a less degree; but when abounding in the latter particular and of a light gray colour, it is besides hard, in a considerable measure tenacious: such iron is always very stiff.

Thus by the two characteristics, colour and lustre, in specimens recently fractured, some judgment may be formed of the properties of cast-iron. In whole castings, the best test of their quality is to strike them on the edges with a hammer; if the blow produce some slight impression in the metal, indicating a degree of malleability, it is tough and good—that is, supposing it to be uniform; if, on the other hand, no sensible indentation takes place, but small fragments fly off, it is brittle and unsuitable. If in those planes which should have been perfectly true, the casting presents an unevenness of surface, it indicates an uniform texture, produced by the admixture of metals of different qualities, which, having different degrees of shrinkage, produce an inequality of strength and tension in the compound that impair the casting and render it liable to sudden failure. For this reason, the utmost care should be observed to render the metal in each casting perfectly uniform throughout; for in the endeavour to produce an iron of a particular quality by mixing together different kinds, it is found difficult to blend them so thoroughly, as to render the compound metal perfectly homogeneous.

Any material defect in a casting, which is not apparent on inspection, may often be discovered by the sound which it emits when struck, unless it consist in internal air bubbles, which are not discoverable by this means; great care should be taken to prevent defects of this kind, and the more time that can be allowed for castings to cool, the better, the iron being tougher when cooled slowly than rapidly, and deriving much the same advantage from it as it would from the annealing process, the object of which is, by retarding the progress to the solid state, to afford the particles more facility for adjusting themselves, and thus to equalize, if not neutralize, the tension produced by the shrinkage in cooling. This is the more necessary when the parts of castings are of unequal thickness; for when the cooling in such cases is rapid and unequal, their solidity is liable to be impaired; and if the difference in their parts is considerable, they are likely to be fractured in the thin parts from the unequal shrinkage; for this reason, it is a common rule to make all the parts of a casting as nearly of the same thickness as possible, that the cooling may proceed everywhere at the same rate.

Appearing, as it does, that castings, in every respect satisfactory to all outward semblance, are yet liable to contain air-bubbles internally, and which cannot be detected by sounding, it follows imperatively, that beams which have to sustain great weights, should be proved under a trial-pressure before they are used.

Cast-iron resists fracture from crushing with nearly seven times the power which it does that from drawing asunder; therefore, supposing the neutral line between the part of a beam which is in a state of compression and that which is in a state of tension to be in the middle of its depth, the lower and upper flanges should be unequal in the proportion of nearly 7 to 1; or, these are the proportions of strength which should subsist between the parts below and above the neutral line, however disposed.

In the late experiments for determining the best sectional form for the tubular bridge across the Menai straits, this important fact was brought to light, that in wrought-iron the relative resistance to tension and compression is in the inverse order of that which holds with respect to cast-iron,—it being found necessary, in experimenting on rectangular tubing (the approved form of section) to make the upper side considerably thicker than the under one, in order to obtain an approximate coincidence in their breaking points: the exact relation which these powers bear to each other has not, we believe, been yet ascertained.

The strength of a beam is not in proportion to the quantity of material—power being obtained rather by the proper disposition of the component parts; and the strongest form is found to be attained by the relation that subsists among the parts of a section consisting of a vertical web, with a flange on its upper and lower edges.

A beam loaded beyond a certain limit continually *yields* to the load, but with an exceedingly slow progression, unless the load very nearly approaches the breaking weight; and though cast-iron may be loaded considerably beyond what has generally been deemed prudent, the beam may be advancing, by however slow degrees, to ultimate destruction.

A load, though uniformly distributed, does not press equally, but increases with the distance from the points of support; therefore, the magnitude of a beam should be increased in like manner. The form of equal strength for a load equally diffused is a semi-ellipse, with the curve at the top; for a load applied in the middle, two equal semi-parabolas placed base to base, with the curves also at the top; and for a load between the middle and one end, two semi-parabolas in like manner, but unequal, their bases meeting in the point of greatest strain. But as, mathematically, these forms occupy, in their lengths, only the extent between the points of support, an extension and spread at the ends is necessary, to afford proper bearings; such being the case, it is obvious that, in lieu of the ellipses—segments of circles, and in lieu of the parabolas—two straight lines meeting in an obtuse angle, are the best forms to be adopted in practice. When circumstances do not admit of a beam being increased in the depth, it should be increased in the breadth instead, according to the various cases above stated, both sides being made alike.

Care should be taken to avoid making any reduction of strength in the lower half of a beam; if bolt-holes in it happen to be unavoidable, there should not be one under the point immediately loaded, and they should be surrounded on each side with a rim fully compensating for the portion abstracted and the continuity of tie interrupted; in the upper half the circumstances are an different, that a series of cross cuts down nearly to the centre have been made in a timber beam and filled with plates of sheet metal for the purpose of stiffening it; perforations for the purpose of lightening a beam are inadmissible in the lower half, but in the upper may be effective of advantage. An extreme of depth in this material is to be avoided, for notwithstanding that much saving is effected by making a beam thin and deep, an excess in this respect renders it rigid, and though calculated to sustain an immense pressure, liable to fracture from a comparatively small impulsive force. Patterns should be slightly bevelled for the purpose of facilitating their removal from the sand without injuring the mould; an allowance should also be made for the contraction of the metal in cooling; the bevel may be about one-eighth of an inch in the foot, the allowance for contraction similar.

Our knowledge of the power of cast-iron columns to resist fracture by direct downward pressure is very limited; indeed so few and vague are our data for determining their proportions, that they seem to be limited to our actual experience; so long, however, as the load is not of an extraordinary nature, and we pay any observance to symmetry, there seems little risk of our reducing their thickness so as to endanger their stability—if we may judge by the story-posts used in the shop fronts of London, which, as Tredgold remarks, are sometimes made so small in respect to their height and the load upon them, that a very slight lateral stroke would break them. But the valuable experiments of Mr. Hodgkinson tend greatly to establish sound practical formulæ on the subject, and indeed have already made considerable progress in doing so; he has found—

That there is a certain proportion of height to diameter, beyond which it would be dangerous to go—the resistance rapidly lessening with the increase of height;

That the relative strength of three pillars, in every respect alike, excepting that the first has both ends flat, the second one end flat and one rounded, and the third both ends rounded, so that the force passes through its axis, is as the numbers 3, 2, and 1;

That a uniform pillar, with its ends firmly fixed, has the same power to resist breaking, as a pillar of the same diameter and half the length, with the ends rounded;

Also, that some additional strength is given to a pillar by enlarging its diameter in the middle;

Long columns give way first at the ends, showing those parts to be the weakest; the inference therefore is, that an increase of sectional area there would be attended with advantage.

PALACES ABROAD AND AT HOME.

Sir,—The editorial writers in the public papers are supposed to be well informed, as they ought to be, on the subject on which they profess to enlighten their readers. It was with no small surprize, however, that I read "a leader" in a Conservative weekly paper of high respectability, of Saturday, the 5th inst., commenting on the proposition which the public mind seems disposed to adopt, viz., the recommendation that a new palace should be built for the sovereign of England, instead of expending money upon Buckingham Palace. The writer in question seems to think that there are already palaces enough, but before enumerating those of the English sovereign, proceeds to mention the royal residences of the king of the French, viz., the "Tuilleries," "a country house at Neuilly," "and he now and then visits St. Cloud;" and "Versailles has a huge palace, but there the king never resides, it is the palace of the people;" thus limiting the number to four; but it would have been more candid in the writer to have added to the list the memorable palace of Fontainbleau, with its magnificent forest of 40,000 acres, and the royal chateaux at Pau, and Eu, making up the number to seven.

The writer then mentions the royal residences in England, viz., Windsor Castle, Hampton Court Palace, Kew Palace, Kensington Palace, the Pavilion at Brighton, Osborne House, and Claremont House, and adds, "Thus her Majesty has at her command no less than seven palaces, all within an easy distance of London, with the palace in Pimlico for her residence, and St. James's for her levées and drawing-rooms. Whether those are enough is more than we can venture to say, but that they are about three times (more?) belonging to any other crowned head in Europe."

The list of "seven palaces," will, however like Falstaff's "seven men in buckram suits," bear reduction, and clearly I have a right to apply to the English the same line of argument which the writer has used for the French royal palaces. But first, I quite agree with the writer in the opinion expressed of Windsor Castle, that it is "beyond all comparison the most stately residence in Europe;"—for Hampton Court I claim the argument used in speaking of Versailles, to say, "there the Queen never resides, it is a 'palace of the people'" (I thank thee for teaching me that word!), and the tens of thousands of persons who annually visit that noble place feel an almost prescriptive right to its enjoyment to the exclusion of "king by kaiser" residing there. Next, Kew Palace has never been "resided in" by her Majesty, and it is too small for she but a branch of the royal family; and although the Gothic palace built at Kew by King George III., cost half a million of money, it was considered (and justly so) the best economy to pull down the fabric, as tasteless as it was expensive. Kensington Palace, since the time of George II., who died there, has not been used as the residence of a reigning monarch. The "Pavilion" at Brighton is doomed to destruction. Her Majesty will never again set foot within that costly gewgaw.* Osborne House is, I believe, her Majesty's private property, and of Claremont the writer in question says, "purchased with public property, it is at her Majesty's disposal, though for the time settled on the King of Belgium." The latter part of this sentence appears to contradict the other.

Thus the "seven palaces at her Majesty's command" dwindle down, so far as actual occupation by the head of this great nation, to a princely country residence, a comfortable seaside villa, and an inconvenient town mansion, not more in number than the allowance of almost every private gentleman of fortune; and instead of being more than belongs to "any other crowned head," it might easily be shown, as in the case of the French monarch, that it is less than falls to the share of European

* The riding-school and stables belonging to the Pavilion are really fine things in their way. If they could be spared, they would be ornaments to the town, and might be made useful.